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A STUDY OF ATMOSPHERIC AEROSOL USING OPTICAL METHODS,(U)

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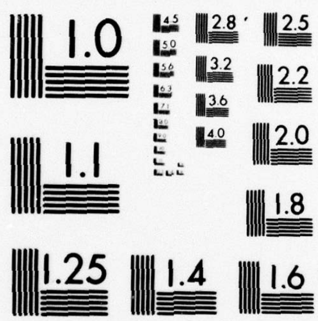
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A STUDY OF ATMOSPHERIC AEROSOL USING OPTICAL METHODS

By

Ye. Ye. Artemkin

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FTD-ID(RS)T-1483-78

EDITED TRANSLATION

FTD-ID(RS)T-1483-78 28 September 1978

MICROFICHE NR: FTD-78-C-001320

CSL74219235

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English pages: 5

Source: Rasseyaniye Sveta v Zemnoy Atmosfere, Izd-Vo "Nauka," Alma-Ata, 1972, pp. 246-250

Country of Origin: USSR
Translated by: Bernard L. Tauber
Requester: FTD/WE
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О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*ye initially, after vowels, and after ъ, ь; e elsewhere.
When written as ё in Russian, transliterate as yё or ё.

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English	Russian	English	Russian	English
sin	sin	sh	sinh	arc sh	$\sinh^{-1}$
cos	cos	ch	cosh	arc ch	$\cosh^{-1}$
tg	tan	th	tanh	arc th	$\tanh^{-1}$
ctg	cot	cth	coth	arc cth	$\coth^{-1}$
sec	sec	sch	sech	arc sch	sech^{-1}
cosec	csc	csch	csch	arc csch	csch^{-1}

Russian	English
rot	curl
lg	log

A STUDY OF ATMOSPHERIC AEROSOL USING OPTICAL METHODS

Ye. Ye. Artemkin

We employed observations of the sky's brightnesses in the violet (λ_1 = 416 nm) and infrared (λ_2 = 1010 nm) regions of the spectrum which were accomplished in Ryazan' using a general-purpose polarization electrophotometer [1] to determine the characteristics of a polydispersed aerosol. (Absorption in the selected wavelengths is absent. For λ_2 = 1010 nm, scattering on aerosols plays the dominating role.)

The measured spectral coefficients and scatter indices, the degree of polarization, and the relationship of the sky's brightnesses were compared with the theoretical values for these quantities [2] which were calculated for an optical aerosol model of the Junge-type.

It was assumed that under city conditions the optical parameters of the Bary, Barun, and Bullrich tables could be used for the polydisperse media with refraction coefficients m = 1.50.

When examining the theoretical values of the "violet-infrared ratio" [3] of the values being analyzed, their unambiguous dependences on the parameters of the polydisperse aerosol were disclosed.

Only those aerosol parameters which were determined by the complex of optical methods being employed and whose values coincided with each other were considered reliable. The formulas for the methods being used are presented in the first line of the table.

1. An analysis of the theoretical calculations [2] of the "violet-infrared ratio" (1) of the sky's spectral energy brightnesses B_{λ_1} and B_{λ_2} for scatter angles ϕ = 100-120° with low positions of the Sun showed that with a change in the lower r_1 and upper r_2 limits of the particle radii it changes insignificantly.

From the table [4] it was established that considerable change in the albedo of the underlying surface has no substantial effect on the value of R_B.

The greatest change in R_B occurs from the Linke turbidity factor T which was also determined from the measurements of this ratio.

Employing the tables in [4] we freed the value B_{λ_1} from the effect of repeated scattering, considering the ratio of the theoretical sky brightnesses proportional to those observed.

For a comparison, the Linke turbidity factor T(λ = 552 nm) was calculated from the formula

$$T' = \frac{\tau_R + \tau_H\left(\frac{\Gamma-1}{\Gamma+1}\right)}{\tau_R}, \qquad (5)$$

where τ_R and τ_D - coefficients of the Rayleigh and aerosol scattering respectively. The value τ_D was calculated in accordance with the interconnection between optical parameters established by G. Sh. Livshitz and V. Ye. Pavlov [5]. The scatter coefficient τ_H was determined from observation of the sky's brightness in the Sun's almucantar; Γ - the "asymmetry" of the scatter indicatrix.

2. Since the relative course of the scatter indicatrix in the region of small angles is virtually independent of the medium's refractive index [6], we employed the data in [2] to find the function for the distribubtion of particles by sizes.

It was considered that for angles of scatter $0°.5 \leq \phi \leq 5°$, the formula of G. van de Hulst is valid [7]. The exponent q which characterizes particle distribution by sizes was determined from measurements of the scatter function with two fixed angles $\phi_1 = 2°$ and $\phi_2 = 5°$.

Analyzing the theoretical calculations in [2], we established that the lower limit of the particle radius r_1 does not introduce substantial changes into the value of q.

For various ν, relationship (3) depends on the upper limit of particle dimensions r_2. In van de Hulst's formula, with a Junge distribution of particles by sizes $q = 4 - \nu$ [7].

Determining the values of q and R_q from observations, we obtain the upper limit of particle dimensions r_2 and parameter ν.

3. According to Foulya [as transliterated] [8], total atmospheric scatter was represented as the sum of the molecular and aerosol coefficient

$$\tau_\lambda = 0{,}00879\lambda^{-4{,}09} + \beta\lambda^{-n}. \qquad (6)$$

Here, the turbidity coefficient of A. Angström β characterizes the quantity of aerosol particles contained in the atmosphere above a given level. It was determined directly from the results of observations of sky brightness for $\lambda \approx 1$ μm in accordance with the formula from [3]

$$\beta = \tau_R + \tau_n\left(\frac{\Gamma-1}{\Gamma+1}\right) - 0{,}00879.$$

The index $n = \nu - 2$ is a measure of the optically effective particle size.

We used the relationships (2) obtained from formula (6) with different values of β and Junge's index ν to determine the latter in accordance with R_τ and β known from observations.

Accepting the mean value of aerosol particle content in the atmosphere from [9], we obtain the following relationship between the coefficient β and the quantity of particles N

$$N \approx 10^5 \beta, \text{см}^3.$$

We calculated the lower limit of particle dimensions from formula (3.18) from [10].

4. From the calculations in [2] it follows that the relationship of the degree of polarization with wavelengths $\lambda_1 = 4.6$ nm and $\lambda_2 = 552$ nm varies depending upon the Linke turbidity factor T and the distribution parameter ν, which permits us to find ν. The determination of ν from maximum polarization is least precise since it is sensitive to a change in the medium's refraction coefficient [6].

The table (see below) provides an example of the use of the methods which have been examined to investigate atmospheric aerosol.

The complex of observable optical characteristics does not contradict Junge's optical model of an aerosol in 40% of the cases. Under conditions of the city of Ryzan', the value of the index of distribution $\nu > 3$.

Метод (1)	$R_B = \frac{B_{\lambda_1}}{B_{\lambda_2}}$ (1)				$R_\tau = \frac{\tau_{\lambda_1}}{\tau_{\lambda_2}}$ (2)					$R_q = \frac{q_{\lambda_1}}{q_{\lambda_2}}$ (3)					$R'_p = \frac{P_{\lambda_1}}{P_{\lambda_2}}$ (4)		
Дата (2)	R_B^H	R_B	T	T'	β	N	R_τ	ν	r_1, 10^{-6} м	q_{λ_1}	q_{λ_2}	R_q	ν_{λ_2}	r_2, 10^{-6} м	T'	R'_p	ν
10. II 1968 г.	—	—	—	3,2	0,220	22000	4,3	2,9	0,025	1,5	1,2	1,2	2,8	7,6	3,2	1,05	4,0
11. II 1968 г.	27,0	10,8	3,0	3,0	0,076	7600	7,2	3,5	0,090	0,9	0,4	2,3	3,6	4,1	3,0	1,12	3,6
20. IV 1968 г.	5,7	—	—	3,5	0,018	1800	25,4	5,4	8,5	1,2	3,4	0,4	0,6	—	3,5	0,93	—
4. VII 1968 г.	33,5	9,5	3,6	3,4	0,052	5200	10,2	3,7	0,600	1,1	0,8	0,4	3,2	6,3	3,4	1,27	2,7
5. VII 1968 г.	8,0	—	—	3,0	0,312	31200	3,2	2,9	0,025	1,0	1,0	1,0	3,0	10,0	3,0	1,12	3,8
6. VII 1968 г.	26,0	5,5	5,5	5,5	0,095	9500	7,3	3,6	0,400	0,7	0,3	2,1	3,7	3,9	5,5	1,04	4.2
8. XI 1967 г.	35,0	12.3	2,6	2,7	0,037	3700	11,1	3,8	0,600	1,5	2,2	0,7	1,8	—	2,7	1,09	3,9

KEY: (1) Method; (2) Date.

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SUMMARY

Based on a comparison of the measured "violet-infrared ratios" of sky brightness, coefficients, and angle functions of sun radiation scattering with Barry, Braun and Bullrich's calculations it is shown that under city conditions the number of measured parameters in 40% cases doesn't contradict the optic model of Junge's aerosol when the particle distribution index is more than 3.

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